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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/916,023	07/26/2001	Christopher C. Hobbs	SC11714TP	8136

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EXAMINER	
TOLEDO, FERNANDO L	
ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 04/07/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/916,023	HOBBS ET AL.	
	Examiner	Art Unit	
	Fernando Toledo	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the corr spond nc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 July 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-10,12-19 and 21-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-10,12-19 and 21-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1, 2, 4, 9, 12, 21, 22 and 24 – 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hegde et al. (U. S. patent 6,383,873 B1) in view of Sadamoto et al. (JP 2000-058515) and in further view of Hobbs (U. S. patent 6,300,202 B1).

In re claims 1, 27, 30 and 31, Hegde in the U. S. patent 6,383,873 B1; figures 1 – 5 and related text, discloses providing a semiconductor substrate 102; forming a metal oxide 106 over the semiconductor substrate; forming a patterned gate electrode 110 over a first portion of the metal oxide layer; removing a second portion of the metal oxide layer, wherein the second portion of the metal oxide layer is adjacent to the first portion of the metal oxide layer.

Hegde does not disclose wherein the removing of the metal oxide includes heating the substrate and flowing a halide-containing chemistry over the substrate while heating.

Sadamoto in the Japanese Patent JP 2000-058515 A, discloses a method of etching a metal oxide using plasma etching wherein the substrate is heated while a halide-containing chemistry is flowed over the substrate while heating to prevent the occurrence of a nonvolatile matter (abstract).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to plasma etch the metal oxide of Hegde as in Sadamoto, since, as

taught by Sadamoto, etching a metal oxide layer with plasma etching technique prevents the occurrence of a nonvolatile matter.

Hedge in view of Sadamoto does not disclose wherein removing the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation.

However, Hobbs in the U. S. patent 6,300,202 B1 substantially discloses the claimed invention and also discloses wherein removing the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation, since, the metal oxide is converted into a material that can then be conventionally etch and shows adequate selectivity with respect to silicon, silicon oxide and silicon nitride (Column 4, lines 38 – 65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to remove the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation, in the invention of Hedge in view of Sadamoto, since, according to Hobbs, the metal oxide is converted into a material that can then be conventionally etch and shows adequate selectivity with respect to silicon, silicon oxide and silicon nitride.

In re claim 2, Sadamoto discloses wherein the halide-containing chemistry further includes hydrogen (abstract).

In re claims 4 and 29, Hegde discloses wherein the metal oxide layer is hafnium oxide (column 2).

In re claims 9 and 28, Hegde in view of Sadamoto does not disclose wherein the step of removing is further characterized as being at a temperature of between about 625 degrees Celsius to 675 degrees Celsius.

However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the substrate of Hegde in view of Sadamoto at a temperature of between about 625 degrees Celsius to 675 degrees Celsius, since temperature is a processing variable and finding the optimum or workable ranges requires only ordinary skill in the art. Note that the specification contains no disclosure of either the critical nature of the claimed temperature ranges or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen temperature ranges or upon another variable recited in a claim, the Applicant must show that the chosen temperature ranges are critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

In re claim 10, Hegde in view of Sadamoto does not disclose wherein the step of removing is further characterized as being at a pressure of about 50 torr for approximately 60 seconds and a flow rate of the halide-containing chemistry at about one SLM.

However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to remove the metal oxide at a pressure of about 50 torr for approximately 60 seconds with a flow rate of the halide-containing chemistry at about one SLM, since it is well known in the art that pressure, time and flow rate are process variable and finding the optimum or workable ranges requires only ordinary skill in the

art. Note that the specification contains no disclosure of either the critical nature of the claimed pressure, time and flow rate or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen pressure, time and flow rate or upon another variable recited in a claim, the Applicant must show that the chosen pressure, time and flow rate are critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

In re claim 12, Sadamoto discloses wherein the heating is performed using a radiation source (figure 1).

In re claim 21, Hegde discloses providing a semiconductor substrate 102; forming a metal oxide layer 106 over the semiconductor substrate; removing a portion of the metal oxide layer.

Hegde does not disclose wherein the removing is done by heating the semiconductor substrate and flowing a gaseous halide.

However, Sadamoto discloses a method of etching a metal oxide using a gaseous halide compound to prevent the occurrence of a nonvolatile matter (abstract).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to etch the metal oxide of Hedge as taught by Sadamoto, since, it will prevent the occurrence of a nonvolatile matter.

Hedge in view of Sadamoto does not disclose wherein removing the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation.

However, Hobbs in the U. S. patent 6,300,202 B1 substantially discloses the claimed invention and also discloses wherein removing the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation, since, the metal oxide is converted into a material that can then be conventionally etch and shows adequate selectivity with respect to silicon, silicon oxide and silicon nitride (Column 4, lines 38 – 65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to remove the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation, in the invention of Hedge in view of Sadamoto, since, according to Hobbs, the metal oxide is converted into a material that can then be conventionally etch and shows adequate selectivity with respect to silicon, silicon oxide and silicon nitride.

In re claim 22, Sadamoto discloses wherein the gaseous halide includes hydrogen (abstract).

In re claim 24, Sadamoto discloses wherein the gaseous halide is HF (abstract).

In re claim 25, Hegde discloses wherein the metal oxide contains hafnium and oxygen (column 2).

In re claim 26, Hegde in view of Sadamoto does not disclose wherein the step of removing is further characterized as being at a temperature of between about 625 degrees Celsius to 675 degrees Celsius.

However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the substrate of Hegde in view of Sadamoto at a

temperature of between about 625 degrees Celsius to 675 degrees Celsius, since temperature is a processing variable and finding the optimum or workable ranges requires only ordinary skill in the art. Note that the specification contains no disclosure of either the critical nature of the claimed temperature ranges or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen temperature ranges or upon another variable recited in a claim, the Applicant must show that the chosen temperature ranges are critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Claims 3, 14 – 19 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hegde in view of Sadamoto as applied to claims 1, 2, 4, 9, 12, 21, 22 and 24 – 26 above, and further in view of Yang et al. (U. S. patent 6,165,375).

In re claims 3 and 23, Hegde in view of Sadamoto discloses wherein the halide-containing chemistry is HF.

Hegde in view of Sadamoto does not disclose wherein the halide-containing chemistry further is HCl.

However, Yang in the U. S. patent 6,165,375; and related text, discloses that HF and HCl are art equivalent materials for plasma etching (column 6).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to etch the invention of Hegde with Sadamoto with HCl instead of HF since Yang discloses that HCl and HF are art recognized equivalents for the disclose intended purpose. Selecting a known material for the disclose intended purpose on the basis of its suitability requires only ordinary skill in the art.

In re claim 14, Hegde discloses providing a semiconductor substrate 102; forming a metal oxide layer 106 over the semiconductor substrate including hafnium and oxygen (column 2); removing a portion of the metal oxide layer.

Hegde does not disclose wherein the removing is done by heating the semiconductor substrate using radiation and flowing a chemistry containing hydrogen and chlorine.

Sadamoto discloses removing an oxide layer by heating a semiconductor substrate using radiation and flowing a chemistry containing hydrogen and fluorine to prevent the occurrence of a nonvolatile matter.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to remove an oxide layer by heating a semiconductor substrate using radiation and flowing a chemistry containing hydrogen and fluorine in the invention of Hegde as disclosed by Sadamoto since it prevents occurrence of nonvolatile matter.

Hegde in view of Sadamoto does not disclose wherein the chemistry includes hydrogen and chlorine.

However, Yang discloses that HF and HCl are art equivalent materials for plasma etching (column 6).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to etch the invention of Hegde with Sadamoto with HCl instead of HF since Yang discloses that HCl and HF are art recognized equivalents for the

disclose intended purpose. Selecting a known material for the disclosed intended purpose on the basis of its suitability requires only ordinary skill in the art.

Hedge in view of Sadamoto does not disclose wherein removing the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation.

However, Hobbs in the U. S. patent 6,300,202 B1 substantially discloses the claimed invention and also discloses wherein removing the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation, since, the metal oxide is converted into a material that can then be conventionally etch and shows adequate selectivity with respect to silicon, silicon oxide and silicon nitride (Column 4, lines 38 – 65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to remove the second portion of the metal oxide layer is performed in a reaction chamber in the absence of rf activation, in the invention of Hedge in view of Sadamoto, since, according to Hobbs, the metal oxide is converted into a material that can then be conventionally etch and shows adequate selectivity with respect to silicon, silicon oxide and silicon nitride.

In re claim 15, Hegde in view of Sadamoto and Yang does not disclose wherein the step of removing is further characterized as being at a temperature of between about 625 degrees Celsius to 675 degrees Celsius.

However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat the substrate of Hegde in view of Sadamoto and Yang

at a temperature of between about 625 degrees Celsius to 675 degrees Celsius, since temperature is a processing variable and finding the optimum or workable ranges requires only ordinary skill in the art. Note that the specification contains no disclosure of either the critical nature of the claimed temperature ranges or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen temperature ranges or upon another variable recited in a claim, the Applicant must show that the chosen temperature ranges are critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

In re claim 16, Hegde discloses wherein the semiconductor substrate includes silicon (column 2).

In re claim 17, Hegde discloses forming a first interfacial oxide layer 104 under the metal oxide layer; removing at least a portion of the first interfacial oxide after removing the portion of the metal oxide layer (figure 4).

In re claim 18, Hegde does not disclose wherein removing at least a portion of the first interfacial oxide layer is performed using a chemistry containing hydrogen and fluorine.

However, Yang discloses that plasma etching using HF is well known in the art to etch silicon dioxide (column 1).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to etch the silicon dioxide of Hegde with a chemistry containing hydrogen and fluorine as taught by Yang since Yang discloses that plasma etching silicon oxide with hydrogen and fluorine is commonly known in the art. The selection of

a known etching process on the basis of its suitability requires only ordinary skill in the art.

In re claim 19, Hedge discloses further including forming a second interfacial oxide 128 over the semiconductor substrate.

7. Claims 5 – 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hegde in view of Sadamoto as applied to claims 1, 2, 4, 9, 12, 21, 22 and 24 – 26 above, and further in view of Moon (U. S. patent 5,621,681).

Hegde in view of Sadamoto does not disclose forming an ARC layer over the patterned gate electrode prior to the flowing of the halide-containing chemistry; and removing the patterned ARC layer after the flowing of the halide-containing chemistry.

However, Moon in the U. S. patent 5,621,681; figures 1 – 5E discloses that to pattern metal oxides in FET technology it is commonly used a hard mask (i.e. ARC layer) formed of silicon nitride to protect the gate electrode and removing the ARC layer after the etching (column 5).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to form an ARC layer (i.e. hard mask) to protect the gate electrode in the invention of Hedge in view of Sadamoto since as taught by Moon ARC layers are commonly used to protect the gate electrode during etching of the metal oxide.

In re claim 6, Hegde discloses forming a first interfacial oxide 104, under the metal oxide layer; removing at least a portion of the first interfacial oxide after removing the second portion of the metal oxide layer (figure 4).

In re claim 7, Hedge in view of Sadamoto and Moon disclose wherein removing a portion of the first interfacial oxide layer is performed using a chemistry containing hydrogen and fluorine.

In re claim 8, Hegde discloses further including forming a second interfacial oxide 128 over the semiconductor substrate.

8. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sadamoto in view of Yang.

Sadamoto discloses placing the semiconductor substrate into a reaction chamber; heating the metal oxide layer; flowing a halide-containing chemistry while heating, wherein the halide-containing chemistry reacts with a portion of the metal oxide layer to create a byproduct, wherein the byproduct includes an element from the metal oxide layer; and removing the byproduct from the reaction chamber.

Sadamoto does not disclose wherein the halide-containing chemistry further is HCl.

However, Yang discloses that HF and HCl are art equivalent materials for plasma etching (column 6).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to etch the invention of Sadamoto with HCl instead of HF since Yang discloses that HCl and HF are art recognized equivalents for the disclose intended purpose. Selecting a known material for the disclosed intended purpose on the basis of its suitability requires only ordinary skill in the art.

Response to Arguments

9. Applicant's arguments with respect to claims 1 – 10, 12 – 19 and 21 – 31 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fernando Toledo whose telephone number is 703-305-0567. The examiner can normally be reached on Mon-Fri 8am to 4pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7382 for regular communications and 703-308-7382 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

George Fourson
Primary Examiner
Art Unit 2823

FToledo
April 4, 2003